

IN THE CLAIMS:

Please amend claims 3, 6, 15, 16, 20-22, 25, 28, 37, 38, 42-44, 47, 50, 59, 60, and 64-66 as follows.

1. (Original) An apparatus for controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, comprising:

temperature estimating means for sequentially estimating the temperature of the active element based on a predetermined element temperature model which is representative of a temperature change of the active element due to heat transfer between at least said active element and an exhaust gas held in contact with the active element, and heater control means for controlling said heater to equalize the temperature of the active element with a predetermined target temperature, using an estimated value of the temperature of the active element from said temperature estimating means.

2. (Original) An apparatus for controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, comprising:

temperature estimating means for sequentially estimating the temperature of the active element based on a predetermined element temperature model which is representative of a temperature change of the active element due to heat transfer between at least said active element and said heater, and heater control means for controlling said

heater to equalize the temperature of the active element with a predetermined target temperature, using an estimated value of the temperature of the active element from said temperature estimating means.

3. (Currently Amended) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 1 ~~or 2~~, wherein said element temperature model comprises a model which is determined to represent, in combination, a temperature change of the active element due to heat transfer between said active element and an exhaust gas held in contact with the active element and a temperature change of the active element due to heat transfer between said active element and said heater.

4. (Original) An apparatus for controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, comprising:

temperature estimating means for sequentially estimating the temperature of the heater based on a predetermined heater temperature model which is representative of a temperature change of the heater due to heat transfer between at least said heater and said active element, and heater control means for controlling said heater to equalize the temperature of the heater with a predetermined target temperature, using an estimated value of the temperature of the heater from said temperature estimating means.

5. (Original) An apparatus for controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an

active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, comprising:

temperature estimating means for sequentially estimating the temperature of the heater based on a predetermined heater temperature model which is representative of a temperature change of the heater due to at least the supply of heating energy to said heater, and heater control means for controlling said heater to equalize the temperature of the heater with a predetermined target temperature, using an estimated value of the temperature of the heater from said temperature estimating means.

6. (Currently Amended) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 4 or ~~5~~, wherein said heater temperature model comprises a model which is determined to represent, in combination, a temperature change of the heater due to heat transfer between said heater and said active element and a temperature change of the heater due to the supply of heating energy to said heater.

7. (Original) An apparatus for controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, comprising:

temperature estimating means for sequentially estimating the temperature of the active element based on a predetermined element temperature model which is representative of, in combination, a temperature change of the active element due to heat transfer between said active element and an exhaust gas held in contact with the active element, and a temperature change of the active element due to heat transfer between the

active element and said heater, and sequentially estimating the temperature of the heater based on a predetermined heater temperature model which is representative of, in combination, a temperature change of the heater due to heat transfer between said heater and said active element and a temperature change of the heater due to the supply of heating energy to said heater; and

heater control means for controlling said heater to equalize the temperature of the active element with a predetermined target temperature, using an estimated value of the temperature of the active element and an estimated value of the temperature of the heater from said temperature estimating means.

8. (Original) An apparatus for controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, comprising:

temperature estimating means for sequentially estimating the temperature of the active element based on a predetermined element temperature model which is representative of, in combination, a temperature change of the active element due to heat transfer between said active element and an exhaust gas held in contact with the active element, and a temperature change of the active element due to heat transfer between the active element and said heater, and sequentially estimating the temperature of the heater based on a predetermined heater temperature model which is representative of, in combination, a temperature change of the heater due to heat transfer between said heater

and said active element and a temperature change of the heater due to the supply of heating energy to said heater; and

heater control means for controlling said heater to equalize the temperature of the heater with a predetermined target temperature, using an estimated value of the temperature of the active element and an estimated value of the temperature of the heater from said temperature estimating means.

9. (Original) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 1, wherein said element temperature model comprises a model which is representative of a change per predetermined time in the temperature of said active element as including a temperature change component depending on the difference between at least the temperature of the active element and the temperature of the exhaust gas held in contact with the active element, and said temperature estimating means sequentially estimates a temperature change of said active element based on said element temperature model, and accumulatively adds an estimated value of the temperature change to an initial value which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the active element.

10. (Original) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 2, wherein said element temperature model comprises a model which is representative of a change per predetermined time in the temperature of said active element as including a temperature change component depending on the difference between at least the temperature of the active element and the temperature of said heater, and said temperature estimating means sequentially estimates a temperature change of

said active element based on said element temperature model, and accumulatively adds an estimated value of the temperature change to an initial value which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the active element.

11. (Original) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 3, wherein said element temperature model comprises a model which is representative of a change per predetermined time in the temperature of said active element as including a temperature change component depending on the difference between the temperature of the active element and the temperature of the exhaust gas held in contact with the active element, and a temperature change component depending on the difference between the temperature of the active element and the temperature of said heater, and said temperature estimating means sequentially estimates a temperature change of said active element based on said element temperature model, and accumulatively adds an estimated value of the temperature change to an initial value which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the active element.

12. (Original) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 4, wherein said heater temperature model comprises a model which is representative of a change per predetermined time in the temperature of said heater as including a temperature change component depending on the difference between the temperature of the heater and the temperature of the active element, and said temperature estimating means sequentially estimates a temperature change of said heater

based on said heater temperature model, and accumulatively adds an estimated value of the temperature change to an initial value which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the heater.

13. (Original) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 5, wherein said heater temperature model comprises a model which is representative of a change per predetermined time in the temperature of said heater as including a temperature change component depending on an amount of heating energy supplied to said heater, and said temperature estimating means sequentially estimates a temperature change of said heater based on said heater temperature model, and accumulatively adds an estimated value of the temperature change to an initial value which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the heater.

14. (Original) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 6, wherein said heater temperature model comprises a model which is representative of a change per predetermined time in the temperature of said heater as including a temperature change component depending on the difference between the temperature of the heater and the temperature of the active element, and a temperature change component depending on an amount of heating energy supplied to said heater, and said temperature estimating means sequentially estimates a temperature change of said heater based on said heater temperature model, and accumulatively adds an estimated value of the temperature change to an initial value which is set when said

internal combustion engine starts to operate, thereby estimating the temperature of the heater.

15. (Currently Amended) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 7 or 8, wherein said element temperature model comprises a model which is representative of a change per predetermined time in the temperature of said active element as including a temperature change component depending on the difference between the temperature of the active element and the temperature of the exhaust gas held in contact with the active element, a temperature change component depending on the difference between the temperature of the active element and the temperature of said heater;

    said heater temperature model comprises a model which is representative of a change per predetermined time in the temperature of said heater as including a temperature change component depending on the difference between the temperature of the heater and the temperature of the active element, and a temperature change component depending on an amount of heating energy supplied to said heater; and

    said temperature estimating means sequentially estimates a temperature change of said active element based on said element temperature model, and accumulatively adds an estimated value of the temperature change to an initial value of the temperature of the active element which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the active element, and sequentially estimates a temperature change of said heater based on said heater temperature model, and accumulatively adds an estimated value of the temperature change to an initial value of

the temperature of the heater which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the heater.

16. (Currently Amended) The apparatus for controlling the temperature of an exhaust gas sensor according to ~~any one of claims 9, 10, 12, and 13~~ claim 9, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

17. (Original) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 11, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

18. (Original) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 14, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

19. (Original) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 15, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

20. (Currently Amended) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 1 ~~or 2~~, wherein said heater control means sequentially generates a control input which determines an amount of heating energy

supplied to said heater, depending on at least the estimated value of the temperature of the active element from said temperature estimating means, and controls said heater depending on the control input.

21. (Currently Amended) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 4 ~~or 5~~, wherein said heater control means sequentially generates a control input which determines an amount of heating energy supplied to said heater, depending on at least the estimated value of the temperature of the heater from said temperature estimating means, and controls said heater depending on the control input.

22. (Currently Amended) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 7 ~~or 8~~, wherein said heater control means sequentially generates a control input which determines an amount of heating energy supplied to said heater by adding an input component depending on at least the estimated value of the temperature of the active element from said temperature estimating means and an input component depending on at least the estimated value of the temperature of the heater from said temperature estimating means, and controls said heater depending on the control input.

23. (Original) A method of controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, comprising:

while sequentially estimating the temperature of the active element based on a predetermined element temperature model which is representative of a temperature change of the active element due to heat transfer between at least said active element and an exhaust gas held in contact with the active element, controlling said heater to equalize the temperature of the active element with a predetermined target temperature, using an estimated value of the temperature of the active element.

24. (Original) A method of controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, comprising:

while sequentially estimating the temperature of the active element based on a predetermined element temperature model which is representative of a temperature change of the active element due to heat transfer between at least said active element and said heater, controlling said heater to equalize the temperature of the active element with a predetermined target temperature, using an estimated value of the temperature of the active element.

25. (Currently Amended) The method of controlling the temperature of an exhaust gas sensor according to claim 23 or 24, wherein said element temperature model comprises a model which is determined to represent, in combination, a temperature change of the active element due to heat transfer between said active element and an exhaust gas held in contact with the active element and a temperature change of the active element due to heat transfer between said active element and said heater.

26. (Original) A method of controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, comprising:

while sequentially estimating the temperature of the heater based on a predetermined heater temperature model which is representative of a temperature change of the heater due to heat transfer between at least said heater and said active element, controlling said heater to equalize the temperature of the heater with a predetermined target temperature, using an estimated value of the temperature of the heater.

27. (Original) A method of controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, comprising:

while sequentially estimating the temperature of the heater based on a predetermined heater temperature model which is representative of a temperature change of the heater due to the supply of heating energy to at least said heater, controlling said heater to equalize the temperature of the heater with a predetermined target temperature, using an estimated value of the temperature of the heater.

28. (Currently Amended) The method of controlling the temperature of an exhaust gas sensor according to claim 26 or 27, wherein said heater temperature model comprises a model which is determined to represent, in combination, a temperature

change of the heater due to heat transfer between said heater and said active element and a temperature change of the heater due to the supply of heating energy to said heater.

29. (Original) A method of controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, comprising:

sequentially estimating the temperature of the active element based on a predetermined element temperature model which is representative of, in combination, a temperature change of the active element due to heat transfer between said active element and an exhaust gas held in contact with the active element, and a temperature change of the active element due to heat transfer between the active element and said heater, and sequentially estimating the temperature of the heater based on a predetermined heater temperature model which is representative of, in combination, a temperature change of the heater due to heat transfer between said heater and said active element and a temperature change of the heater due to the supply of heating energy to said heater, and controlling said heater to equalize the temperature of the active element with a predetermined target temperature, using an estimated value of the temperature of the active element and an estimated value of the temperature of the heater while estimating the temperature of the active element and the temperature of the heater.

30. (Original) A method of controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active

element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, comprising:

sequentially estimating the temperature of the active element based on a predetermined element temperature model which is representative of, in combination, a temperature change of the active element due to heat transfer between said active element and an exhaust gas held in contact with the active element, and a temperature change of the active element due to heat transfer between the active element and said heater, and sequentially estimating the temperature of the heater based on a predetermined heater temperature model which is representative of, in combination, a temperature change of the heater due to heat transfer between said heater and said active element and a temperature change of the heater due to the supply of heating energy to said heater, and controlling said heater to equalize the temperature of the heater with a predetermined target temperature, using an estimated value of the temperature of the active element and an estimated value of the temperature of the heater while estimating the temperature of the active element and the temperature of the heater.

31. (Original) The method of controlling the temperature of an exhaust gas sensor according to claim 23, wherein said element temperature model comprises a model which is representative of a change per predetermined time in the temperature of said active element as including a temperature change component depending on the difference between at least the temperature of the active element and the temperature of the exhaust gas held in contact with the active element, and while sequentially estimating a temperature change of said active element based on said element temperature model, an

estimated value of the temperature change is accumulatively added to an initial value which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the active element.

32. (Original) The method of controlling the temperature of an exhaust gas sensor according to claim 24, wherein said element temperature model comprises a model which is representative of a change per predetermined time in the temperature of said active element as including a temperature change component depending on the difference between at least the temperature of the active element and the temperature of said heater, and while sequentially estimating a temperature change of said active element based on said element temperature model, an estimated value of the temperature change is accumulatively added to an initial value which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the active element.

33. (Original) The method of controlling the temperature of an exhaust gas sensor according to claim 25, wherein said element temperature model comprises a model which is representative of a change per predetermined time in the temperature of said active element as including a temperature change component depending on the difference between the temperature of the active element and the temperature of the exhaust gas held in contact with the active element, and a temperature change component depending on the difference between the temperature of the active element and the temperature of said heater, and while sequentially estimating a temperature change of said active element based on said element temperature model, an estimated value of the

temperature change is accumulatively added to an initial value which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the active element.

34. (Original) The method of controlling the temperature of an exhaust gas sensor according to claim 26, wherein said heater temperature model comprises a model which is representative of a change per predetermined time in the temperature of said heater as including a temperature change component depending on the difference between the temperature of the heater and the temperature of the active element, and while sequentially estimating a temperature change of said heater based on said heater temperature model, an estimated value of the temperature change is accumulatively added to an initial value which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the heater.

35. (Original) The method of controlling the temperature of an exhaust gas sensor according to claim 27, wherein said heater temperature model comprises a model which is representative of a change per predetermined time in the temperature of said heater as including a temperature change component depending on an amount of heating energy supplied to said heater, and while sequentially estimating a temperature change of said heater based on said heater temperature model, an estimated value of the temperature change is accumulatively added to an initial value which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the heater.

36. (Original) The method of controlling the temperature of an exhaust gas sensor according to claim 28, wherein said heater temperature model comprises a model

which is representative of a change per predetermined time in the temperature of said heater as including a temperature change component depending on the difference between the temperature of the heater and the temperature of the active element, and a temperature change component depending on an amount of heating energy supplied to said heater, and while sequentially estimating a temperature change of said heater based on said heater temperature model, an estimated value of the temperature change is accumulatively added to an initial value which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the heater.

37. (Currently Amended) The method of controlling the temperature of an exhaust gas sensor according to claim 29 or 30, wherein said element temperature model comprises a model which is representative of a change per predetermined time in the temperature of said active element as including a temperature change component depending on the difference between the temperature of the active element and the temperature of the exhaust gas held in contact with the active element, a temperature change component depending on the difference between the temperature of the active element and the temperature of said heater;

    said heater temperature model comprises a model which is representative of a change per predetermined time in the temperature of said heater as including a temperature change component depending on the difference between the temperature of the heater and the temperature of the active element, and a temperature change component depending on an amount of heating energy supplied to said heater; and

while sequentially estimating a temperature change of said active element based on said element temperature model, an estimated value of the temperature change is accumulatively added to an initial value of the temperature of the active element which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the active element, and while sequentially estimating a temperature change of said heater based on said heater temperature model, an estimated value of the temperature change is accumulatively added to an initial value of the temperature of the heater which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the heater.

38. (Currently Amended) The method of controlling the temperature of an exhaust gas sensor according to ~~any one of claims 31, 32, 34, and 35~~ claim 31, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

39. (Original) The method of controlling the temperature of an exhaust gas sensor according to claim 33, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

40. (Original) The method of controlling the temperature of an exhaust gas sensor according to claim 36, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

41. (Original) The method of controlling the temperature of an exhaust gas sensor according to claim 37, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

42. (Currently Amended) The method of controlling the temperature of an exhaust gas sensor according to claim 23 ~~or 24~~, wherein while sequentially generating a control input which determines an amount of heating energy supplied to said heater, depending on at least the estimated value of the temperature of the active element, said heater is controlled depending on the control input.

43. (Currently Amended) The method of controlling the temperature of an exhaust gas sensor according to claim 26 ~~or 27~~, wherein while sequentially generating a control input which determines an amount of heating energy supplied to said heater, depending on at least the estimated value of the temperature of the heater, said heater is controlled depending on the control input.

44. (Currently Amended) The method of controlling the temperature of an exhaust gas sensor according to claim 29 ~~or 30~~, wherein while sequentially generating a control input which determines an amount of heating energy supplied to said heater by adding an input component depending on at least the estimated value of the temperature of the active element and an input component depending on at least the estimated value of the temperature of the heater, said heater is controlled depending on the control input.

45. (Original) A recording medium readable by a computer and storing a temperature control program for enabling the computer to perform a process of

controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, wherein:

    said temperature control program comprises a temperature estimating program for enabling said computer to perform a process of sequentially estimating the temperature of the active element based on a predetermined element temperature model which is representative of a temperature change of the active element due to heat transfer between at least said active element and an exhaust gas held in contact with the active element, and a heater control program for enabling said computer to perform a process of controlling said heater to equalize the temperature of the active element with a predetermined target temperature, using an estimated value of the temperature of the active element.

46. (Original) A recording medium readable by a computer and storing a temperature control program for enabling the computer to perform a process of controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, wherein:

    said temperature control program comprises a temperature estimating program for enabling said computer to perform a process of sequentially estimating the temperature of the active element based on a predetermined element temperature model which is representative of a temperature change of the active element due to heat transfer between at least said active element and said heater, and a heater control program for enabling said

computer to perform a process of controlling said heater to equalize the temperature of the active element with a predetermined target temperature, using an estimated value of the temperature of the active element.

47. (Currently Amended) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 45 or 46, wherein said element temperature model comprises a model which is determined to represent, in combination, a temperature change of the active element due to heat transfer between said active element and an exhaust gas held in contact with the active element and a temperature change of the active element due to heat transfer between said active element and said heater.

48. (Original) A recording medium readable by a computer and storing a temperature control program for enabling the computer to perform a process of controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, wherein:

    said temperature control program comprises a temperature estimating program for enabling said computer to perform a process of sequentially estimating the temperature of the heater based on a predetermined heater temperature model which is representative of a temperature change of the heater due to heat transfer between at least said heater and said active element, and a heater control program for enabling said computer to perform a process of controlling said heater to equalize the temperature of the heater with a

predetermined target temperature, using an estimated value of the temperature of the heater.

49. (Original) A recording medium readable by a computer and storing a temperature control program for enabling the computer to perform a process of controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, wherein:

    said temperature control program comprises a temperature estimating program for enabling said computer to perform a process of sequentially estimating the temperature of the heater based on a predetermined heater temperature model which is representative of a temperature change of the heater due to at least the supply of heating energy to said heater, and a heater control program for enabling said computer to perform a process of controlling said heater to equalize the temperature of the heater with a predetermined target temperature, using an estimated value of the temperature of the heater.

50. (Currently Amended) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 48 or 49, wherein said heater temperature model comprises a model which is determined to represent, in combination, a temperature change of the heater due to heat transfer between said heater and said active element and a temperature change of the heater due to the supply of heating energy to said heater.

51. (Original) A recording medium readable by a computer and storing a temperature control program for enabling the computer to perform a process of

controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, wherein:

    said temperature control program comprises a temperature estimating program for enabling said computer to perform a process of sequentially estimating the temperature of the active element based on a predetermined element temperature model which is representative of, in combination, a temperature change of the active element due to heat transfer between said active element and an exhaust gas held in contact with the active element, and a temperature change of the active element due to heat transfer between the active element and said heater, and sequentially estimating the temperature of the heater based on a predetermined heater temperature model which is representative of, in combination, a temperature change of the heater due to heat transfer between said heater and said active element and a temperature change of the heater due to the supply of heating energy to said heater; and

    a heater control program for enabling said computer to perform a process of controlling said heater to equalize the temperature of the active element with a predetermined target temperature, using an estimated value of the temperature of the active element and an estimated value of the temperature of the heater.

52. (Original) A recording medium readable by a computer and storing a temperature control program for enabling the computer to perform a process of controlling the temperature of an exhaust gas sensor disposed in an exhaust passage of an

internal combustion engine and having an active element for contacting an exhaust gas flowing through the exhaust passage and a heater for heating the active element, wherein:

    said temperature control program comprises a temperature estimating program for enabling said computer to perform a process of sequentially estimating the temperature of the active element based on a predetermined element temperature model which is representative of, in combination, a temperature change of the active element due to heat transfer between said active element and an exhaust gas held in contact with the active element, and a temperature change of the active element due to heat transfer between the active element and said heater, and sequentially estimating the temperature of the heater based on a predetermined heater temperature model which is representative of, in combination, a temperature change of the heater due to heat transfer between said heater and said active element and a temperature change of the heater due to the supply of heating energy to said heater; and

    a heater control program for enabling said computer to perform a process of controlling said heater to equalize the temperature of the heater with a predetermined target temperature, using an estimated value of the temperature of the active element and an estimated value of the temperature of the heater.

53. (Original) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 45, wherein said element temperature model comprises a model which is representative of a change per predetermined time in the temperature of said active element as including a temperature change component depending on the difference between at least the temperature of the active element and

the temperature of the exhaust gas held in contact with the active element, and said temperature estimating program comprises a program for enabling the computer to perform a process of sequentially estimating a temperature change of said active element based on said element temperature model, and accumulatively adding an estimated value of the temperature change to an initial value which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the active element.

54. (Original) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 46, wherein said element temperature model comprises a model which is representative of a change per predetermined time in the temperature of said active element as including a temperature change component depending on the difference between at least the temperature of the active element and the temperature of said heater, and said temperature estimating program comprises a program for enabling the computer to perform a process of sequentially estimating a temperature change of said active element based on said element temperature model, and accumulatively adding an estimated value of the temperature change to an initial value which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the active element.

55. (Original) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 47, wherein said element temperature model comprises a model which is representative of a change per predetermined time in the temperature of said active element as including a temperature change component depending on the difference between the temperature of the active element and the

temperature of the exhaust gas held in contact with the active element, and a temperature change component depending on the difference between the temperature of the active element and the temperature of said heater, and said temperature estimating program comprises a program for enabling the computer to perform a process of sequentially estimating a temperature change of said active element based on said element temperature model, and accumulatively adding an estimated value of the temperature change to an initial value which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the active element.

56. (Original) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 48, wherein said heater temperature model comprises a model which is representative of a change per predetermined time in the temperature of said heater as including a temperature change component depending on the difference between the temperature of the heater and the temperature of the active element, and said temperature estimating program comprises a program for enabling the computer to perform a process of sequentially estimating a temperature change of said heater based on said heater temperature model, and accumulatively adding an estimated value of the temperature change to an initial value which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the heater.

57. (Original) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 49, wherein said heater temperature model comprises a model which is representative of a change per predetermined time in the temperature of said heater as including a temperature change component depending on an

amount of heating energy supplied to said heater, and said temperature estimating program comprises a program for enabling the computer to perform a process of sequentially estimating a temperature change of said heater based on said heater temperature model, and accumulatively adds an estimated value of the temperature change to an initial value which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the heater.

58. (Original) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 50, wherein said heater temperature model comprises a model which is representative of a change per predetermined time in the temperature of said heater as including a temperature change component depending on the difference between the temperature of the heater and the temperature of the active element, and a temperature change component depending on an amount of heating energy supplied to said heater, and said temperature estimating program comprises a program for enabling the computer to perform a process of sequentially estimating a temperature change of said heater based on said heater temperature model, and accumulatively adding an estimated value of the temperature change to an initial value which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the heater.

59. (Currently Amended) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 51 or 52, wherein said element temperature model comprises a model which is representative of a change per predetermined time in the temperature of said active element as including a temperature

change component depending on the difference between the temperature of the active element and the temperature of the exhaust gas held in contact with the active element, a temperature change component depending on the difference between the temperature of the active element and the temperature of said heater;

    said heater temperature model comprises a model which is representative of a change per predetermined time in the temperature of said heater as including a temperature change component depending on the difference between the temperature of the heater and the temperature of the active element, and a temperature change component depending on an amount of heating energy supplied to said heater; and

    said temperature estimating program comprises a program for enabling the computer to perform a process of sequentially estimating a temperature change of said active element based on said element temperature model, and accumulatively adding an estimated value of the temperature change to an initial value of the temperature of the active element which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the active element, and sequentially estimating a temperature change of said heater based on said heater temperature model, and accumulatively adding an estimated value of the temperature change to an initial value of the temperature of the heater which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the heater.

60. (Currently Amended) The recording medium storing a temperature control program for an exhaust gas sensor according to ~~any one of claims 53, 54, 56, and 57~~ claim 53, wherein said initial value is set depending on the atmospheric temperature

and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

61. (Original) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 55, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

62. (Original) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 58, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

63. (Original) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 59, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

64. (Currently Amended) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 45 ~~or 46~~, wherein said heater control program comprises a program for enabling said computer to perform a process of sequentially generating a control input which determines an amount of heating energy supplied to said heater, depending on at least the estimated value of the temperature of the active element, and controlling said heater depending on the control input.

65. (Currently Amended) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 48 ~~or 49~~, wherein said heater

control program comprises a program for enabling said computer to perform a process of sequentially generating a control input which determines an amount of heating energy supplied to said heater, depending on at least the estimated value of the temperature of the heater, and controlling said heater depending on the control input.

66. (Currently Amended) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 51 or 52, wherein said heater control program comprises a program for enabling said computer to perform a process of sequentially generating a control input which determines an amount of heating energy supplied to said heater by adding an input component depending on at least the estimated value of the temperature of the active element and the estimated value of the temperature of the heater, and controlling said heater depending on the control input.

Please add new claims 67-108 as follows:

67. (New) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 2, wherein said element temperature model comprises a model which is determined to represent, in combination, a temperature change of the active element due to heat transfer between said active element and an exhaust gas held in contact with the active element and a temperature change of the active element due to heat transfer between said active element and said heater.

68. (New) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 5, wherein said heater temperature model comprises a model which is determined to represent, in combination, a temperature change of the heater due to heat

transfer between said heater and said active element and a temperature change of the heater due to the supply of heating energy to said heater.

69. (New) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 67, wherein said element temperature model comprises a model which is representative of a change per predetermined time in the temperature of said active element as including a temperature change component depending on the difference between the temperature of the active element and the temperature of the exhaust gas held in contact with the active element, and a temperature change component depending on the difference between the temperature of the active element and the temperature of said heater, and said temperature estimating means sequentially estimates a temperature change of said active element based on said element temperature model, and accumulatively adds an estimated value of the temperature change to an initial value which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the active element.

70. (New) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 68, wherein said heater temperature model comprises a model which is representative of a change per predetermined time in the temperature of said heater as including a temperature change component depending on the difference between the temperature of the heater and the temperature of the active element, and a temperature change component depending on an amount of heating energy supplied to said heater, and said temperature estimating means sequentially estimates a temperature change of said heater based on said heater temperature model, and accumulatively adds an

estimated value of the temperature change to an initial value which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the heater.

71. (New) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 8, wherein said element temperature model comprises a model which is representative of a change per predetermined time in the temperature of said active element as including a temperature change component depending on the difference between the temperature of the active element and the temperature of the exhaust gas held in contact with the active element, a temperature change component depending on the difference between the temperature of the active element and the temperature of said heater;

    said heater temperature model comprises a model which is representative of a change per predetermined time in the temperature of said heater as including a temperature change component depending on the difference between the temperature of the heater and the temperature of the active element, and a temperature change component depending on an amount of heating energy supplied to said heater; and

    said temperature estimating means sequentially estimates a temperature change of said active element based on said element temperature model, and accumulatively adds an estimated value of the temperature change to an initial value of the temperature of the active element which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the active element, and sequentially estimates a temperature change of said heater based on said heater temperature model, and

accumulatively adds an estimated value of the temperature change to an initial value of the temperature of the heater which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the heater.

72. (New) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 10, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

73. (New) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 12, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

74. (New) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 13, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

75. (New) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 69, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

76. (New) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 70, wherein said initial value is set depending on the atmospheric

temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

77. (New) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 71, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

78. (New) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 2, wherein said heater control means sequentially generates a control input which determines an amount of heating energy supplied to said heater, depending on at least the estimated value of the temperature of the active element from said temperature estimating means, and controls said heater depending on the control input.

79. (New) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 5, wherein said heater control means sequentially generates a control input which determines an amount of heating energy supplied to said heater, depending on at least the estimated value of the temperature of the heater from said temperature estimating means, and controls said heater depending on the control input.

80. (New) The apparatus for controlling the temperature of an exhaust gas sensor according to claim 8, wherein said heater control means sequentially generates a control input which determines an amount of heating energy supplied to said heater by adding an input component depending on at least the estimated value of the temperature of the active element from said temperature estimating means and an input component

depending on at least the estimated value of the temperature of the heater from said temperature estimating means, and controls said heater depending on the control input.

81. (New) The method of controlling the temperature of an exhaust gas sensor according to claim 24, wherein said element temperature model comprises a model which is determined to represent, in combination, a temperature change of the active element due to heat transfer between said active element and an exhaust gas held in contact with the active element and a temperature change of the active element due to heat transfer between said active element and said heater.

82. (New) The method of controlling the temperature of an exhaust gas sensor according to claim 27, wherein said heater temperature model comprises a model which is determined to represent, in combination, a temperature change of the heater due to heat transfer between said heater and said active element and a temperature change of the heater due to the supply of heating energy to said heater.

83. (New) The method of controlling the temperature of an exhaust gas sensor according to claim 81, wherein said element temperature model comprises a model which is representative of a change per predetermined time in the temperature of said active element as including a temperature change component depending on the difference between the temperature of the active element and the temperature of the exhaust gas held in contact with the active element, and a temperature change component depending on the difference between the temperature of the active element and the temperature of said heater, and while sequentially estimating a temperature change of said active element based on said element temperature model, an estimated value of the temperature

change is accumulatively added to an initial value which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the active element.

84. (New) The method of controlling the temperature of an exhaust gas sensor according to claim 82, wherein said heater temperature model comprises a model which is representative of a change per predetermined time in the temperature of said heater as including a temperature change component depending on the difference between the temperature of the heater and the temperature of the active element, and a temperature change component depending on an amount of heating energy supplied to said heater, and while sequentially estimating a temperature change of said heater based on said heater temperature model, an estimated value of the temperature change is accumulatively added to an initial value which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the heater.

85. (New) The method of controlling the temperature of an exhaust gas sensor according to claim 30, wherein said element temperature model comprises a model which is representative of a change per predetermined time in the temperature of said active element as including a temperature change component depending on the difference between the temperature of the active element and the temperature of the exhaust gas held in contact with the active element, a temperature change component depending on the difference between the temperature of the active element and the temperature of said heater;

said heater temperature model comprises a model which is representative of a change per predetermined time in the temperature of said heater as including a temperature change component depending on the difference between the temperature of the heater and the temperature of the active element, and a temperature change component depending on an amount of heating energy supplied to said heater; and

while sequentially estimating a temperature change of said active element based on said element temperature model, an estimated value of the temperature change is accumulatively added to an initial value of the temperature of the active element which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the active element, and while sequentially estimating a temperature change of said heater based on said heater temperature model, an estimated value of the temperature change is accumulatively added to an initial value of the temperature of the heater which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the heater.

86. (New) The method of controlling the temperature of an exhaust gas sensor according to claim 32, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

87. (New) The method of controlling the temperature of an exhaust gas sensor according to claim 34, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

88. (New) The method of controlling the temperature of an exhaust gas sensor according to claim 35, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

89. (New) The method of controlling the temperature of an exhaust gas sensor according to claim 83, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

90. (New) The method of controlling the temperature of an exhaust gas sensor according to claim 84, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

91. (New) The method of controlling the temperature of an exhaust gas sensor according to claim 85, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

92. (New) The method of controlling the temperature of an exhaust gas sensor according to claim 24, wherein while sequentially generating a control input which determines an amount of heating energy supplied to said heater, depending on at least the estimated value of the temperature of the active element, said heater is controlled depending on the control input.

93. (New) The method of controlling the temperature of an exhaust gas sensor according to claim 27, wherein while sequentially generating a control input which determines an amount of heating energy supplied to said heater, depending on at least the estimated value of the temperature of the heater, said heater is controlled depending on the control input.

94. (New) The method of controlling the temperature of an exhaust gas sensor according to claim 30, wherein while sequentially generating a control input which determines an amount of heating energy supplied to said heater by adding an input component depending on at least the estimated value of the temperature of the active element and an input component depending on at least the estimated value of the temperature of the heater, said heater is controlled depending on the control input.

95. (New) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 46, wherein said element temperature model comprises a model which is determined to represent, in combination, a temperature change of the active element due to heat transfer between said active element and an exhaust gas held in contact with the active element and a temperature change of the active element due to heat transfer between said active element and said heater.

96. (New) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 49, wherein said heater temperature model comprises a model which is determined to represent, in combination, a temperature change of the heater due to heat transfer between said heater and said active element and a temperature change of the heater due to the supply of heating energy to said heater.

97. (New) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 95, wherein said element temperature model comprises a model which is representative of a change per predetermined time in the temperature of said active element as including a temperature change component depending on the difference between the temperature of the active element and the temperature of the exhaust gas held in contact with the active element, and a temperature change component depending on the difference between the temperature of the active element and the temperature of said heater, and said temperature estimating program comprises a program for enabling the computer to perform a process of sequentially estimating a temperature change of said active element based on said element temperature model, and accumulatively adding an estimated value of the temperature change to an initial value which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the active element.

98. (New) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 96, wherein said heater temperature model comprises a model which is representative of a change per predetermined time in the temperature of said heater as including a temperature change component depending on the difference between the temperature of the heater and the temperature of the active element, and a temperature change component depending on an amount of heating energy supplied to said heater, and said temperature estimating program comprises a program for enabling the computer to perform a process of sequentially estimating a temperature change of said heater based on said heater temperature model, and accumulatively adding

an estimated value of the temperature change to an initial value which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the heater.

99. (New) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 52, wherein said element temperature model comprises a model which is representative of a change per predetermined time in the temperature of said active element as including a temperature change component depending on the difference between the temperature of the active element and the temperature of the exhaust gas held in contact with the active element, a temperature change component depending on the difference between the temperature of the active element and the temperature of said heater;

    said heater temperature model comprises a model which is representative of a change per predetermined time in the temperature of said heater as including a temperature change component depending on the difference between the temperature of the heater and the temperature of the active element, and a temperature change component depending on an amount of heating energy supplied to said heater; and

    said temperature estimating program comprises a program for enabling the computer to perform a process of sequentially estimating a temperature change of said active element based on said element temperature model, and accumulatively adding an estimated value of the temperature change to an initial value of the temperature of the active element which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the active element, and sequentially estimating a

temperature change of said heater based on said heater temperature model, and accumulatively adding an estimated value of the temperature change to an initial value of the temperature of the heater which is set when said internal combustion engine starts to operate, thereby estimating the temperature of the heater.

100. (New) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 54, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

101. (New) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 56, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

102. (New) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 57, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

103. (New) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 97, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

104. (New) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 98, wherein said initial value is set depending on

the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

105. (New) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 99, wherein said initial value is set depending on the atmospheric temperature and/or the temperature of the internal combustion engine at least when said internal combustion engine starts to operate.

106. (New) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 46, wherein said heater control program comprises a program for enabling said computer to perform a process of sequentially generating a control input which determines an amount of heating energy supplied to said heater, depending on at least the estimated value of the temperature of the active element, and controlling said heater depending on the control input.

107. (New) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 49, wherein said heater control program comprises a program for enabling said computer to perform a process of sequentially generating a control input which determines an amount of heating energy supplied to said heater, depending on at least the estimated value of the temperature of the heater, and controlling said heater depending on the control input.

108. (New) The recording medium storing a temperature control program for an exhaust gas sensor according to claim 52, wherein said heater control program comprises a program for enabling said computer to perform a process of sequentially generating a

control input which determines an amount of heating energy supplied to said heater by adding an input component depending on at least the estimated value of the temperature of the active element and the estimated value of the temperature of the heater, and controlling said heater depending on the control input.